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APPLICATION TRANSMITTAL SHEET

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In re application of
Inventor: ALEXANDER LIFSON
Title: **PULSED FLOW FOR CAPACITY CONTROL**

Enclosed are:

1 sheet(s) of drawings

1 specification (including claims)

1 declaration and power of attorney.

The filing fee has been calculated as shown below:

For:	NO. FILED	NO. EXTRA	RATE	FEE
Basic Fee				$790.00
Total Claims	8 (-20)	0	X22	-0-
Indep. Claims	3 (-3)	0	X82	-0-
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PULSED FLOW FOR CAPACITY CONTROL

Background of the invention

In a closed air conditioning or refrigeration system there are a number of methods of unloading that can be employed. Commonly assigned U. S. Patent 4,938,666 discloses unloading one cylinder of a bank by gas bypass and unloading an entire bank by suction cutoff. Commonly assigned U. S. Patent 4,938,029 discloses the unloading of an entire stage of compressor and the use of an economizer. Commonly assigned U. S. Patent 4,878,818 discloses the use of a valved common port to provide communication with suction for unloading or with discharge for V_i control, where V_i is the discharge pressure to suction pressures ratio. In employing these various methods, the valve structure is normally fully open, fully closed, or the degree of valve opening is modulated so as to remain at a certain fixed position. One problem associated with these arrangements is that capacity can only be controlled in steps or expensive motor driven modulation valves must be employed to fix the valve opening at a certain position for capacity control.

Summary of the Invention

Gradual compressor capacity can be achieved by rapidly cycling solenoid valve(s) between fully open and fully closed positions. The cycling solenoid valve(s) can be located in the compressor suction line, the compressor economizer line and/or the compressor bypass line which connects the economizer line to the suction line. The percentage of time that a valve is open determines the degree of modulation being achieved. However, because the cycling time is so much shorter than the response time of the system, it is as though the valve(s) are partially opened rather than being cycled between their open and closed positions.

It is an object of this invention to provide continuous capacity control.

It is another object of this invention to provide step control in capacity modulation.

It is a further object of this invention to provide a less expensive alternative to the use of variable speed compressors.

It is another object of this invention to provide a less expensive alternative to a modulation valve. These objects, and others as will become apparent hereinafter, are accomplished by the present invention.

Basically, gradual or step control in capacity modulation of a refrigeration circuit is achieved by rapidly cycling a solenoid valve in the compressor suction line and/or the compressor economizer line and/or bypass line.

Brief Description of the Drawing

For a fuller understanding of the present invention, reference should now be made to the following detailed description thereof taken in conjunction with the accompanying drawing wherein.

The FIGURE is a schematic representation of an economized refrigeration or air conditioning system employing the present invention.

Description of the Preferred Embodiment

In the FIGURE, the numeral 12 generally designates a hermetic compressor in a closed refrigeration or air conditioning system 10. Starting with compressor 12, the system 10 serially includes discharge line 14, condenser 16, line 18, expansion device 20, evaporator 22, and suction line 24 completing the circuit. Line 18-1 branches off from line 18 and contains expansion device 30 and connects with compressor 12 via port 12-1 at a location corresponding to an intermediate point in the compression process. Economizer heat exchanger 40 is located such that line 18-1 downstream of expansion device 30 and line 18 upstream of expansion device 20 are in heat exchange relationship. The expansion devices 20 and 40 are labeled as electronic expansion devices, EEV, and are illustrated as connected to microprocessor 100. In the case of expansion device 20, at least, it need not be an EEV and might, for example be a thermal expansion device, TEV. What has been described so far is

generally conventional. The present invention provides bypass line 50 connecting lines 18-1 and 24 downstream of economizer heat exchanger 40 and evaporator 22, respectively, and places solenoid valve 52 in line 50, solenoid valve 54 in line 24 downstream of evaporator 22 and upstream of line 50 and solenoid valve 56 in line 18-1 downstream of economizer heat exchanger 40 and upstream of line 50. Solenoid valves 52, 54, and 56 and EEV30 are all controlled by microprocessor 100 responsive to zone inputs. Where expansion device 20 is, as illustrated, an EEV, it also is controlled by microprocessor 100.

In "normal" operation of system 10, valves 52 and 56 are closed and hot high pressure refrigerant gas from compressor 12 is supplied via line 14 to condenser 16 where the refrigerant gas condenses to a liquid which is supplied via line 18 and idle economizer heat exchanger 40 to EEV20. EEV20 causes a pressure drop and partial flashing of the liquid refrigerant passing therethrough. The liquid-vapor mixture of refrigerant is supplied to evaporator 22 where the liquid refrigerant evaporates to cool the required space and the resultant gaseous refrigerant is supplied to compressor 12 via suction line 24 containing solenoid valve 54 to complete the cycle.

The operation described above is conventional and capacity is controlled through EEV20. Pursuant to the teachings of the present invention solenoid valve 54 can be rapidly pulsed to control the capacity of compressor 12 since the pulsing will be more rapid than the response time of the system 10, the system 10 responds as though the valve 54 is partially open rather than being cycled between its open and closed positions. Modulation is achieved by controlling the percentage of the time that valve 54 is on and off. To prevent a vacuum pump operation, the "off" position of valve 54 may need to permit a limited flow.

To increase capacity of system 10, economizer heat exchanger 40 is employed. In economizer heat exchanger 40, lines 18 and 18-1 are in heat exchange relationship. Solenoid valve 56 is open and solenoid valve 52 closed and a portion of the liquid refrigerant in line 18 is directed into line 18-1 where EEV30 causes a pressure drop and a partial flashing of the liquid refrigerant. The low pressure liquid refrigerant passes into economizer heat exchanger 40 where the refrigerant in line 18-1 extracts

heat from the refrigerant in line 18 causing it to cool further and thereby provide an increased cooling effect in evaporator 22. The refrigerant in line 18-1 passing through economizer heat exchanger 40 is supplied to compressor 12 via port 12-1 under the control of valve 56 which is, in turn, controlled by microprocessor 100. Line 18-1 delivers refrigerant gas to a trapped volume at an intermediate stage of compression in the compressor 12, as is conventional. However, according to the teachings of the present invention the economizer flow in line 18-1 and, as such, system capacity is controlled by rapidly cycling valve 56 to modulate the amount of economizer flow to an intermediate stage of compression in compressor 12. To lower the capacity of system 10, bypass line solenoid valve 52 is employed. In this arrangement, valve 56 is closed, and gas at intermediate pressure is bypassed from compressor 12 via port 12-1, line 18-1 and line 50 into suction line 24. The amount of bypassed gas and, as such, the system capacity is varied by rapidly cycling valve 52. Thus port 12-1 is used as both an economizer port and a bypass or unloading port.

From the foregoing, it should be clear that the rapid cycling of valves 52, 54 and 56, individually, allows for various forms of capacity control with the amount of time a particular valve is on relative to the time that it is off determining the degree of modulation of capacity. The frequency of modulation for typical systems can range from 0.1 to 100 seconds.

Although preferred embodiments of the present invention have been illustrated and described, other changes will occur to those skilled in the art. It is therefore intended that the scope of the present invention is to be limited only by the scope of the appended claims.

CLAIMS

What is Claimed is:

1. In a system serially including a compressor, a discharge line, a condenser, an expansion device, an evaporator and a suction line, means for achieving capacity control comprising:

a solenoid valve in said suction line;

means for rapidly pulsing said solenoid valve whereby the rate of flow in said suction line to said compressor is modulated.

2. The capacity control of claim 1 further including a fluid path connected to said compressor at a location corresponding to an intermediate point of compression in said compressor.

3. The capacity control of claim 2 further including:

a bypass line connected to said fluid path and said suction line;

a solenoid valve in said bypass line;

means for rapidly pulsing said solenoid valve in said bypass line whereby the rate of flow of bypass to said suction line is modulated.

4. The capacity control of claim 3 further including;

an economizer circuit connected to said fluid path;

a solenoid valve in said economizer circuit; and

means for rapidly pulsing said solenoid valve in said economizer circuit whereby the rate of economizer flow to said compressor is modulated.

5. The capacity control of claim 2 further including;

an economizer circuit connected to said fluid path;

a solenoid valve in said economizer circuit; and

means for rapidly pulsing said solenoid valve in said economizer circuit whereby the rate of economizer flow to said compressor is modulated.

6. In a system serially including a compressor, a discharge line, a condenser, an expansion device, an evaporator and a suction line, means for achieving capacity control comprising:

a fluid path connected to said compressor at a location corresponding to an intermediate point of compression in said compressor;

a bypass line connected to said fluid path and said suction line;

a solenoid valve in said bypass line;

means for rapidly pulsing said solenoid valve in said bypass line whereby the rate of flow of bypass to said suction line is modulated.

7. The capacity control of claim 6 further including;

an economizer circuit connected to said fluid path;

a solenoid valve in said economizer circuit; and

means for rapidly pulsing said solenoid valve in said economizer circuit whereby the rate of economizer flow to said compressor is modulated.

8. In a system serially including a compressor, a discharge line, a condenser, an expansion device, an evaporator and a suction line, means for achieving capacity control comprising:

a fluid path connected to said compressor at a location corresponding to an intermediate point of compression in said compressor;

an economizer circuit connected to said fluid path;

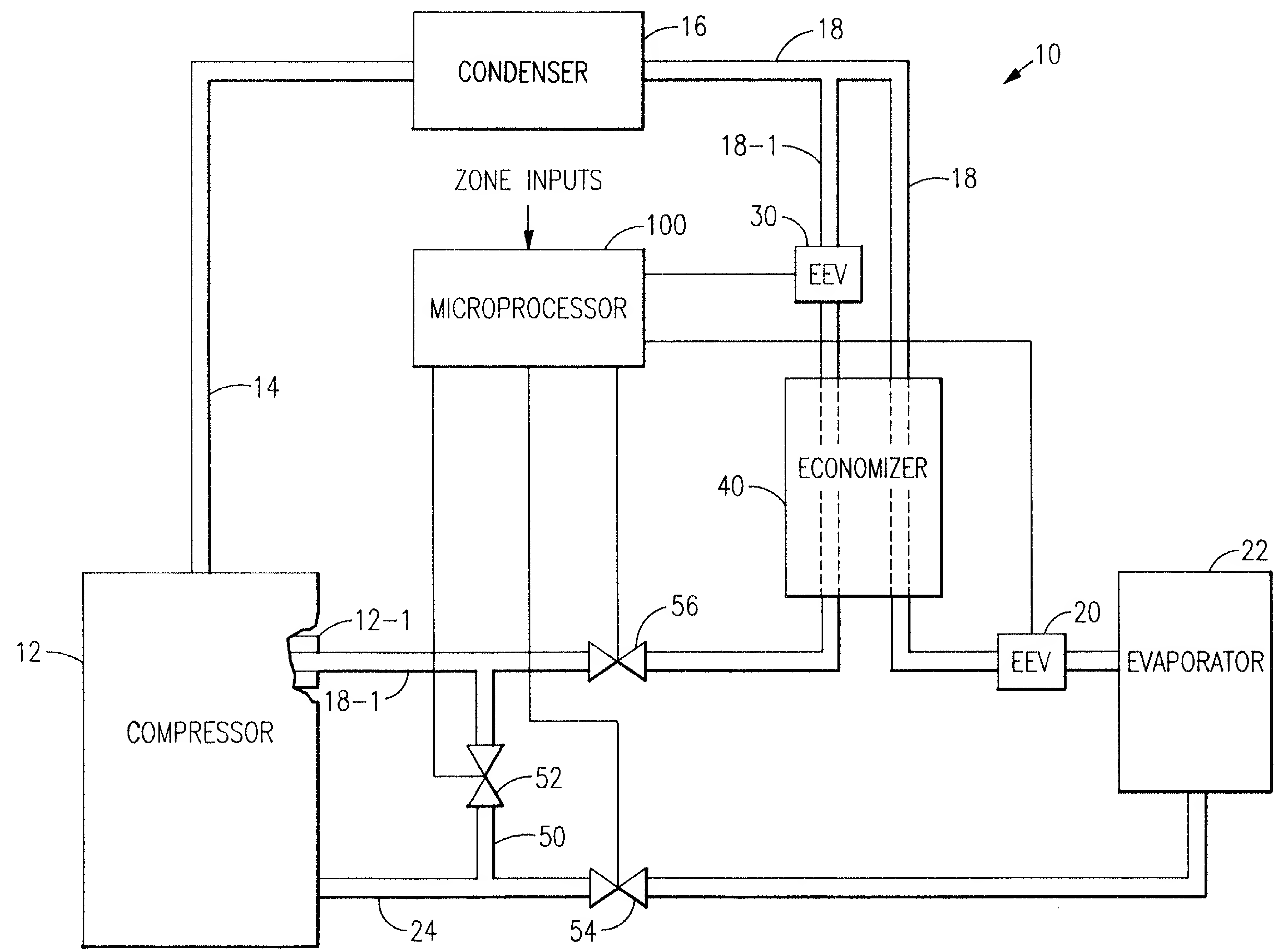
a solenoid valve in said economizer circuit; and

means for rapidly pulsing said solenoid valve in said economizer circuit whereby the rate of economizer flow to said compressor is modulated.

PULSED FLOW FOR CAPACITY CONTROL

ABSTRACT OF THE DISCLOSURE

Step control in capacity modulation of a refrigeration or air conditioning circuit is achieved by rapidly cycling a solenoid valve in the suction line, economizer circuit or in a bypass with the percent of "open" time for the valve regulating the rate of flow therethrough. A common port in the compressor is used for economizer flow and for bypass.


CONDENSER
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40
22
56
20
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EVAPORATOR
18-1
COMPRESSOR
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24
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DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

English Language Declaration

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled:

PULSED FLOW FOR CAPACITY CONTROL

the specification of which

_X_ is attached hereto

____ was filed on _____ as

Application Serial No._____

and was amended on _____

(if applicable)

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the Patent and Trademark Office all information known to me to be material to patentability as defined in 37 C.F.R. 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s)			Priority Claimed	
_____	_____	_____	_____	_____
(number)	(country)	(date filed)	yes	no
_____	_____	_____	_____	_____
(number)	(country)	(date filed)	yes	no
_____	_____	_____	_____	_____
(number)	(country)	(date filed)	yes	no

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

_____	_____	_____
(application serial no.)	(filing date)	(status)
_____	_____	_____
(application serial no.)	(filing date)	(status)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agents(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.

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